IT instruments for Problem Based Learning in Undergraduate Medical Education

Tudor Calinici[1], Florina Nistor[2], Dan Istrate[3], Tudor Drugan[4]

Abstract

Problem Based Learning (PBL) is one of the many alternative methods that can be used in medical education. There are different views about its advantages and limitation, but the added value of this method is well recognized. PBL helps students to develop team working and collaboration. It is useful to have an IT solution to support the PBL process.

The goal of this research was to identify a web application which has implemented the facilities necessary for Problem Base Learning at the curriculum level: security, collaborative environment, availability, and easy to use. A PBL scenario was developed and a demo Problem Base Learning session had place. The participants were students enrolled in first year at Faculty of Medicine, and the Problem Base Learning topic was biostatistics.

We use Moodle as IT support for Problem Based Learning process. A Problem Based Learning session took place and it was a success. The students had no problem using the on-line interface and the general conclusion was that Moodle is a viable option to be used as support for PBL sessions.

Moodle seems to be an appropriate Web 2.0 instrument to be used as support for Problem Based Learning. It is very important to recognize that Moodle is just a tool which facilitates learning but it not guarantee of the success. The success of the Problem Based Learning method in medical education is in the involvement of the students, in the skills of the facilitator and in the quality of the clinical scenario.

Keywords: Problem Base Learning, E-learning, Moodle

Introduction
Problem based learning (PBL) is an educational method in which the learning is made by solving specific problems, using both interaction and individual study, and supervised by a teacher – called facilitator. In medical area, a PBL session will start from a real life situation, most of the time a clinical scenario, which is read and, under the supervision of the facilitator, the students identify the unknown topics that must be understand and learned. After that, the students have a period of time for individual study. The group is rejoining and, applying the new learned knowledge, the problem is solved. [1]

PBL was used for the first time in medical education in late 60’s, at McMaster University in Canada. The reason for implementing this new method was the statement that the process for diagnosing a patient is based by a combination of clinical reasoning and specific knowledge in different domains. By learning specific disciplines (anatomy, physiology, neurology, pharmacology) as individual ones, the students fail to integrate the knowledge in clinical context and have difficulties in applying in the practice. The advance of the medical science and the rapid changing of the specific approaches was also an argument for the use of the PBL as educational method in medical education. [2,3]

The validity of this method in medical education was studied by Albanese and Mitchell in a meta-analysis which contains 20 studies evaluating PBL results [4]. The conclusion was that there was no significant difference between the results of the conventional tests (ex. national examinations) between the students that prepare themself using PBL and the students who use the traditional way, but the PBL students were better on clinical abilities. Another study carried by Denton et all. [5] reported the same results but also the preference of the students for PBL.

PBL is a student centered method, so the student has to find out by himself what must be learned, he has to process the information and activate the previous knowledge. In this way he will learn only the things that he considers to be essentials in his own style and pace. This thing motivates the student, and it is easier for him to learn, because he was the one who establish both the learning objectives and the way in which those must be archived. Another strong point of this method is that the students will gain the ability not only to identify what they have to learn but to find the relevant bibliography. So, it is very important that the facilitator not to give to the students the bibliographical resources, only to guide them in identifying the topics that must be learned. The success of the method stays in the students wish to develop themselves both professional and personal. Starting from the problem, the students will learn not only more information about the subject, but also how to learn and where to find relevant information. [1,2]

The main principles of PBL are open answer questions and study in group. The problems are the learning vehicles and the group is their fuel.[6] The problems used in PBL session must be written in such way so the solution is not evident. To stimulate own-motivation, the problems must be realistic and the scenarios must be in resonance with the students experience. The solutions must be complex enough, they must include more interconnected parts and all the process must motivate the students to feel the need for knowledge and learning. When the students launch hypotheses in front of the group, they publicly exposed their level of knowledge and they are preparing themself for future learning. Good problems need multidisciplinary approaches and help to develop the communication abilities. [7]. The students must identify the key concepts, to find resources and to collaborate. When a student learns and understands a topic, he automatically applies this knowledge to find the solution for the problem. He must explain it to the others, so the learning became active. Doing that, the students develop social and cognitive abilities, assume responsibilities and gain new knowledge.

The second main principle of PBL is the group study. The students examine the problem together, coordinate their efforts, cooperate for a collective scope and collaborate for summarizing and presenting the conclusions.[8] Students will work in small groups – 4-8 persons, guided by a facilitator. To reach the maximum efficacy, the group will need
3 to 5 sessions together. Different members of the group will have, from time to time, different roles – the coordinator of the discussion, the writer, the reader of the case, etc. There are situations where the problem is presented to the group as a written scenario, which must be read, in order, but at the same time, by all the group members.[1]

The implementation of PBL in medical education was done after a detailed analyze of the way in which doctors react in front of a patient. Barrows [9] divided the clinical reasoning in the following steps:

- Receiving and interpreting the information
- Generating hypotheses
- Research strategy and clinical abilities
- Formulating the problem
- Diagnose and / or therapeutically approach (conclusion)

This steps of the clinical thinking occur very fast in the mind of the practitioners so, their presence, in many times is unnoticed. PBL allows the identification of these steps and the students will gain the ability to properly approach them. [2] Based on this, there are many implementations of PBL method on different medical universities, the most common one being the 7 steps Maastricht method [10]:

1. Identifying and clarifying the unknown terms from the clinical scenario – a student will write all the unexplained terms
2. Defining the problem or the problems which must be discussed – students may have different opinions about this, all the opinions must be taken in consideration, a student will write a list of the problems
3. A brainstorming session to discuss the problems, to suggest the solutions – the students are using their previous knowledge in order to identify what knowledge is missing – a student will record the discussion
4. Reviewing steps 2 and 3 – organizing the notes
5. Formulation of the learning objectives – the group reach the consensus for learning objectives, the facilitator ensures that the learning objectives are appropriate, reachable and comprehensive
6. Individual study – all the students gain information about the topics
7. The group share the information – the students solve the problem, the facilitator is able to verify if the learning objectives are reached and also can assess the students.

The role of the facilitator is critical in PBL. The facilitator is responsible for moving between the steps and for the monitoring of the group and its dynamic. This is important, because during PBL sessions, all the students must join the discussion, share opinions and discuss other ideas. [7]

The way in which the students are assessed determines how the students learn. If the assessing is based on the capability of the students to memorize facts and information, with a big probability, the PBL implementation will fail. The evaluation must be appropriate with the PBL principles. The evaluation must be made during the group activity. The
feedback of the facilitator is essential. The group must be encouraged to reflect on their performance, both as individual and as group. The evaluation at the group level (all the students receive the same grade) encourages the students to reach the PBL objectives. [11] Another important component of the evaluation is the receiving feedback from the others colleagues in group. This means the presence, the ability for listening and speaking, the quality of information, the ability to add value to the group etc.[12]

Having all of this in mind, the goal of the research was to identify a proper Web 2.0 tool to be use as support for PBL. The application must cover the needs for the Maastricht 7 steps method and the research team will check its capabilities but also its acceptance from the students.

### Material and Methods

The scope of this research was to identify, implement, test and assess a web application which covers the facilities necessary for Problem Base Learning at the curriculum level: security, collaborative environment, availability, and easy to use. The application must fit the existing hardware and software infrastructure and the implementation must be made without any supplementary costs – no license fee, no supplementary software costs. The installation, configurations, maintenance process and administration tasks must easy to be performed, for the application to fit the existing human infrastructure – no specialized personnel for web-based application. The community of users for this application must be large enough to ensure that the most common problems are documented and the most frequent issues could be solved with own resources.

On the following infrastructure:

- OS: Debian 8 [13]
- Web Server: Apache 2.0 [14]
- DB: MySQL 5.5.49 [15]
- PHP 5.6 [16]

we install a Moodle 2.9 instance [17] (current 3.0.3+)

To test the platform we use a sample of 21 students enrolled in first year at the Faculty of Medicine, who studied Biostatistics, part of the regular curriculum. The students were volunteers to join the study, the participation at the study ensuring a bonus at the final grade on Biostatistics exam. Before the study, the students had no previous experience in PBL or in using Moodle and they were regular computer users, having no advanced IT skills.

There were two group meetings, the time between them being one week. At both meetings, al 21 students participated, under the supervision of a facilitator. At the first meeting, before the problem to be presented, the Moodle instance was presented to the students and they were instructed how to access the platform, how to log at the platform and how to access the section reserved for this purpose – approx. 15 minutes of instruction. After that, the problem base learning method was presented to the students, and they receive the text for a real life scenario which involves knowledge in bio statistical area – collecting and analyzing data. In approx. 40 min., being guided by the facilitator, the students debated the problem, find 10 educational objectives and assigned each objective to be handled by a group of 2 or 3 students (9 educational objectives – groups of 2 students, 1 educational objective – group of 3 students). Every student was assigned to a group; no students should handle more than one educational objective. The Moodle platform was used as a support to collect both educational objectives and the responsible persons. Having one week time, the students had the task to put the adequate educational material for learning the
specific topics and to study it, and at the second meeting the students put together the pieces of the puzzle and solve the problem.

After solving the problem, they were asked to complete a questionnaire with questions about their opinion on the PBL and on the issues they front when they used Moodle as support tool for PBL. The questionnaire was created using Google Forms [18] and contained 8 questions with closed answer and one question with open answer. The questions are presented in Table 1.

Table 1. The evaluation questionnaire

<table>
<thead>
<tr>
<th>Topic</th>
<th>Issue</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moodle</td>
<td>General level of difficulty in use</td>
<td>Closed question 1 –Very difficult ... 4 Not difficult at all</td>
</tr>
<tr>
<td></td>
<td>Technical issues</td>
<td>Closed question 1 –A lot ... 4 None</td>
</tr>
<tr>
<td></td>
<td>Enjoyable</td>
<td>Closed question 1 –I hate it ... 4 It is good</td>
</tr>
<tr>
<td></td>
<td>Willing to use in future</td>
<td>Closed question 1 –Never ... 4 Very much</td>
</tr>
<tr>
<td></td>
<td>Moodle as support for PBL</td>
<td>Closed question 1 –Inappropriate ... 4 Appropriate</td>
</tr>
<tr>
<td>PBL</td>
<td>Is it interesting?</td>
<td>Closed question 1 –Not at all ... 4 Yes, very</td>
</tr>
<tr>
<td></td>
<td>Team work</td>
<td>Closed question 1 –I hate it ... 4 I love it</td>
</tr>
<tr>
<td></td>
<td>Compare with traditional method</td>
<td>Closed question 1 –Not as good 2 Same results</td>
</tr>
<tr>
<td>Both</td>
<td>What do you like most?</td>
<td>Open question</td>
</tr>
</tbody>
</table>

The data collected from the questioners were analyzed using Microsoft Excel 2010.

Results

Evaluating the platform

The implementation of Moodle instance is available at [http://web.umfcluj.ro/moodle/](http://web.umfcluj.ro/moodle/)

In order to be appropriate to be use as support for Problem Base Learning, Moodle must provide at least these characteristics: security, collaborative environment, availability, and easy to use.

To access the reserved section, each student had to log in using authentication credentials. Using the administration interface we were able to import the credentials which students were using to log on the department's LAN, so there was no need of supplementary credentials. Once they log on, the students were able to access only the section designed to be support for PBL.

To ensure the collaborative environment, we use the Wiki object from the Moodle activities repository. The result was a document space which can be accessed and edited simultaneous by all the users, on which the students were able both to add the educational material and to learn from the educational material added by the other members of
the group. A snapshot of the workspace can be found in Figure 1.

![PBL workspace](image)

**Figure 1.** The PBL workspace. View mode – left, edit mode – right

In total, the students use as educational material 4 videos from YouTube, two externals websites and 6 custom files (word documents, excel documents, PowerPoint presentation and one avi file)

To assess the availability issue, we motorized both the platform and the Apache web server. During the period of the study, the application was up and running, the logs recorded 0 failures.

We were able to install and configure the Moodle instance without having many difficulties, being able to solve the issues using the Moodle manuals. The students were able to use the application as well, after only 15 minutes of verbal instruction. The Moodle administration interface is very intuitive so there were no problems in setting up and administrating the PBL workspace.

*The student's opinion*

All of the 21 students completed the questionnaire. The distribution of the answers is presented in Table 2

<table>
<thead>
<tr>
<th>Topic</th>
<th>Issue</th>
<th>Responses (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1  2  3  4</td>
</tr>
</tbody>
</table>

Table 2. The answers
When we consider which application could be appropriate to be the support for PBL, Moodle was our number one choice, because we had very good experiences in other domains [19, 20]. However, the experience in using Moodle is not a factor for decrease of the Moodle qualities. The installing process is well documented, the administration interface is very clear and the platform has a very user-friendly interface. The availability of a large collection of templates, allow us to integrate the design of the platform to the other web applications of the department. Moodle fits perfectly with our infrastructure, but our experience showed that Moodle can be used on other different infrastructures (ex. Windows infrastructure). With small effort we were able to configure this instance of Moodle to be used not only in browser from different devices and OS (Windows, MacOs, Android) but as mobile app as well.

The specific of medical sciences assume, by tradition, the assimilation in the first years of a very big amount of information. This, combined with the cultural tradition which is very professor-centered, make difficult the implementation of PBL in the late years, so it was a big advantage that we use first year students. On the other hand, because the lack of medical knowledge, it is difficult to create appropriate scenarios so PBL method could be used.

The literature recommends that PBL to be used on small groups [1]. We had violated this assumption because we were not interested in how much the students learn but in evaluation of the IT platform.

An interesting fact about the educational material used by the students for learning the topics identified in PBL section was that they use almost the same proportion of traditional material – documents, web-sites and YouTube videos. This is an advantage of using IT tools, allowing to use multimedia as learning material. In fact, almost any object that can be seen in browser, could be used as learning material with Moodle. This property leads to ethical issues, regarding the copyright of the learning material.

All of the students agreed that Moodle is appropriate to serve as support for Problem Based Learning process; most of the students enjoy using it and are willing to use it in different context. However, only half of them believe that they can obtain at least the same results like using the traditional method for teaching and learning.

The study has limitations. There are many other web applications which can be used as support for PBL. Moodle is just one of them and it was selected by the authors of the study because their experience in using it. It could be an idea for a future research to compare which application fit the best the PBL specific. Another limitation is provided

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**Table:**

<table>
<thead>
<tr>
<th>Moodle</th>
<th>General level of difficulty in use</th>
<th>-</th>
<th>-</th>
<th>38</th>
<th>62</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical issues</td>
<td></td>
<td>-</td>
<td>-</td>
<td>67</td>
<td>32</td>
</tr>
<tr>
<td>Enjoyable</td>
<td></td>
<td>-</td>
<td>14</td>
<td>67</td>
<td>19</td>
</tr>
<tr>
<td>Willing to use in future</td>
<td></td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>90</td>
</tr>
<tr>
<td><strong>Moodle as support for PBL</strong></td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>PBL</td>
<td>Is it interesting?</td>
<td>-</td>
<td>10</td>
<td>71</td>
<td>19</td>
</tr>
<tr>
<td>Team work</td>
<td></td>
<td>5</td>
<td>10</td>
<td>62</td>
<td>24</td>
</tr>
<tr>
<td>Compare with traditional method</td>
<td></td>
<td>43</td>
<td>57</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
by the sample of the students. They were no random selected, they were volunteers, motivated to use the application.

Last but not the least, we must state once again that the success of the PBL method is in the level of the involvement of the students. For this, there are other important conditions: the appropriate problem, a good facilitator, and only after that, a good IT instrument for support.

Conclusions

Moodle proved to be a good Web 2.0 instrument to be used as support for Problem Based Learning. It contains the mandatory features to support the PBL activity: security, collaborative environment, availability, and easy to use. The students in the sample used it without having serious difficulties and consider it appropriate to be use as support instrument for PBL.

Take Home Messages

- Moodle proved to be a good Web 2.0 instrument to be used as support for Problem Based Learning.
- It contains the mandatory features to support the PBL activity: security, collaborative environment, availability, and easy to use.
- The students in the sample used it without having serious difficulties and consider it appropriate to be use as support instrument for PBL.

Notes On Contributors

Tudor Calinici is lecturer at the Department of Medical Education, Medical Informatics and Biostatistics Discipline.

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Appendices

Declaration of Interest

The author has declared that there are no conflicts of interest.